Exhibit A

AECL EACL

S99- Detailed Report

PROTECTED - SENSITIVE

CRL-508760-FM-323 Rev. 1

Ref. Procedure CRL-508760-PRO-343

Section 1: Problem Identification	
ImpAct No. NRU-09-04289	
ImpAct Title Heavy Water Leak	
Discovery Date 2009 May 15	Location s.16(2) NRU [redacted]
Facility Branch NRU	Date/Time Occurred 2009 May 15
Equipment ID N/A	
Conditions Prior to Problem, including Reactor Power Level if applicable On 2009 May 14 at 15:22h the reactor tripped on Unit 39 due to a loss of Class IV power, and a poison outage was conceded. Class IV power was restored at 00:38h on 2009 May 15.	
Description of the Problem On 2009 May 15, a small leak of heavy water was detected from the NRU reactor. The leak rate of approximately 5 kg/h was well within the capabilities of NRU's make-up system, and therefore did not pose an immediate safety risk for the reactor. Tritium releases associated with the water leak were above weekly action levels but remained well below regulatory limits. The prudent course of action was taken to keep the reactor shut down to locate and repair the leak. On 2009 May 18, the leak was located on the outside of the NRU vessel. A remote camera showed water seeping out of a corrosion deposit on the outer wall near the bottom of the vessel.	
Immediate Action Taken Immediately following indication of a leak, actions focussed on enhanced oversight of nuclear safety were implemented. These actions included increased monitoring of NRU's leak detection systems, increased monitoring of the heavy water level in the vessel, increased availability of heavy water for addition to the system and ensuring staff readiness should the emergency cooling system automatically initiate as designed. Longer-term initiatives were then undertaken to contain the leaking water, to control the emissions of tritium, and to determine the cause and extent of condition. The water leakage was collected by a purpose-designed NRU system, and transferred to specially-designed drums for storage and eventual disposition. Evaporation was removed by the NRU ventilation system, protecting workers from tritium exposures. The tritium emissions with the evaporation remained below 0.1% of the regulatory limit (extrapolated to a full year). Efforts were made to reduce the leakage by lowering the water level in the NRU vessel, and adding a solution of material to block the leak path. By the end of June, fuel, isotope and control rods had been removed from the reactor vessel and the water level was reduced, resulting in a 10-fold decrease in leak rate. In mid-July, the vessel was completely drained, which stopped the water leak. Extensive visual and non-destructive examinations have revealed a band of corrosion around the lower outer surface of the vessel. The corrosion resulted in "dish-shaped" areas of regional wall loss, and a few highly localized cavities. It was one of the latter cavities that led to the heavy-water leak.	
Remarks on Conditions Prior to Problem N/A	
Remarks on Description of the Problem N/A	
Remarks on Immediate Action Taken N/A	

Review of Operating Experience / Previous Similar Conditions

[redacted]

Extent of Condition

An extensive investigation has been completed for corrosion of the NRU vessel, and the sites that require remediation have been identified, including the leak site.

In addition, a review is underway of NRU systems for degradation mechanisms that may not have been previously adequately addressed. The outcome of this review, and any required actions, will be documented separately.

Cause Analysis Conclusions

Technical Cause

An extensive inspection has been conducted to determine the technical cause of the corrosion on the outside of the vessel and extent of the degraded condition. This inspection included:

- visual examinations of the outer and inner surfaces of the vessel wall,
- ultrasonic testing (UT) and eddy-current testing (ET) measurements of the wall thickness and vessel condition,
- microscopic and chemical examination of various components removed from the annulus, and
- destructive examination of material removed from the vessel wall.

The visual and non-destructive examinations have revealed a circumferential band of corrosion on the outer surface of the reactor vessel at the bottom of the annulus. In general, this corrosion has resulted in insignificant thinning of the vessel wall. Within the band, however, there are regions where there has been more substantial wall thinning. In these regions the vessel wall has been corroded in a shallow "dish" shape. In some cases, the remaining wall thickness at the minimum of the dish is less than 1 mm (of the original ~8 mm). In addition to the general corrosion there are a few sites where highly localized corrosion has penetrated the vessel wall. It was at one of these sites of localized corrosion that the vessel wall was penetrated and led to the heavy water leak.

The corrosion of the NRU vessel was due to nitric acid produced from air and water leaking into the annulus between the vessel and the water reflector. Radiolysis of the air in the presence of water produces nitric acid, which corrodes the aluminum vessel. The larger patches would result from water containing nitric acid impinging on the vessel wall (e.g. splashing and spraying). Destructive examination of a coupon removed from the vessel wall adjacent to the leak site indicates that the localized corrosion is due to an electrochemical mechanism where water leaking into the base of the annulus meets acidic water running down the vessel wall leading to an aggressive local water chemistry. For both the general corrosion and local penetration, the primary agent for corrosion was most likely nitric acid.

Organizational Cause

An organizational root cause analysis has provided valuable insight into process issues and resulting actions that will provide lasting improvements and contribute to the organization's future success. Some of these same organizational causes were identified in the Talisman Report commissioned jointly by the CNSC and AECL in 2008 June.

When reviewing the organizational root causes, it is important to recognize that a complex series of events has occurred over the years, resulting in actions that sometimes differ from common industry management practices. These events mainly include changes in public policy affecting the operation and funding of Chalk River Laboratories and the planning assumption that an extended NRU outage to address maintenance issues would be taken following the Dedicated Isotope Facilities (DIF) becoming operational.

The NRU reactor plays a significant role in medical isotope supply (30% globally). Delays with the DIF project and its eventual cancellation in 2008 May, placed increased operating demands on NRU.

An investigation into the organizational causes for the event has revealed the following causal factors:

1. *Changing Future of NRU*: NRU's mission and planned life have changed several times over the past two decades, which has

placed NRU's maintenance and condition under pressure. In 1996, AECL informed the Atomic Energy Control Board that the NRU reactor would not be operated beyond 2005 December 31. Also in 1996 the MDS Nordion Medical Isotopes Reactor (MMIR) contract was signed to have the Dedicated Isotope Facilities project in-service in accordance with its terms. This contributed to a shorter-term focus for operation of NRU.

2. *Focus on Short-Term Isotope Production*: An extended outage for NRU may result in shortages in isotope supply, which makes preventative work requiring an extended outage very difficult to plan and schedule.

3. *Symptom-Based Problem Solving*: A lack of questioning attitude by staff led to problems being addressed by focussing on symptoms and not by looking for root causes and extent of condition. As a result, evidence that there was corrosion of the lower vessel was not sufficiently considered (e.g., deterioration of the CO2 header at the bottom of the annulus and visual examinations of the annulus for other purposes that showed corrosion on the vessel wall).

4. *Ineffective Use of Operating Experience*: Until recently, NRU, like other research reactors, was not considered to be part of the nuclear power reactor community. Consequently, there has been little learning from power reactor organizations.

5. *Low Standards and Acceptance of Plant Operational Problems*: When repair attempts were not fully effective, and light-water leakage persisted, it was accepted as a "normal" operating condition for NRU, and the focus was on managing the light-water leakage rather than prevention.

6. *Less Than Adequate Management Oversight*: Historically CRL management did not ensure high standards for operation and that strong barriers were in place to prevent events.

These causal factors point to certain barriers that were either non-existent or compromised, and which could have prevented the event. Having said that, the event evolved over a number of decades and the assessment is based on current standards and practices for operation. In some cases, the barriers would not have been expected to be in place at that time.

Looking at the organization, as it exists now, there have been a number of improvements introduced that address causal factors for the event. For example:

- In 2005, a Chief Nuclear Officer position was introduced and staffed to bring in utility standards and an operational focus. This has resulted in increased attention to nuclear and conventional safety, and elements of a learning organization being established.
- A Leadership Academy was implemented in 2006 to train leaders and ensure they share a common understanding of expectations and standards for operation.
- In 2007, the position of Chief Nuclear Engineer/Design Authority was created for Research and Technology Operations. This has resulted in establishing engineering programs that reflect current industry practice for supporting operations such as change control, operability evaluations, configuration management, and system/equipment health monitoring.
- Following the decision to discontinue the Dedicated Isotope Facilities in 2008, the Isotope Supply Reliability Program was established to ensure that the reliability of isotope production is improved by addressing plant, process and people issues in NRU, and other facilities supporting isotope production.
- In 2008, AECL secured a trial membership in the World Association of Nuclear Operators that brings training, workshops, technical support missions, and the peer review process, all of which will help raise standards and improve practices.
- The position of Vice-President and General Manager of Operations was staffed in 2009 with an individual with broad nuclear industry experience.

The above improvements have been implemented in recent years and have been effective in addressing some, but not all aspects of the causal factors. In assessing the safety culture of today, the following organizational barriers still require further improvement:

- Accountability: Staff and management tend to not accept responsibility and to regard "best-effort" as sufficient rather than taking responsibility for achieving results.
- Standards: Standards for operation are not in-line with current utility industry practice.
- Technical Support: There is a tendency to solve issues within a work group or to under value support, rather than seek input from other work groups, or beyond AECL.
- Questioning Attitude: Staff and management can be overly optimistic, without appropriate challenging of assumptions.

Asking, "Why are these barriers weakened, or what fundamental organizational failing has these symptoms?" points to an underlying organizational cause:

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Asking, "Why are these barriers weakened, or what fundamental organizational failing has these symptoms?" points to an underlying organizational cause:

> *The organization's culture had evolved to being complacent and unchallenging, where "bad news" was often not communicated.*

Root Cause Analysis (RCA)

4468-00-E Rev 3

Event Title	Rev.	RCA No.
Heavy Water Leak s.18(b) s.18(d)	0	NRU - 09 - 04289
		Impact No.
		NRU-09-04289

[redacted]

Event Title	Rev.	RCA No.
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[redacted]

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[redacted]

8.5 Aging Management

CSA N286.5-95 [12] outlines requirements for plant performance monitoring (section 6.1) and chemistry control (section 7), which would be part of, in today's nomenclature, an aging management program. These requirements are typically incorporated into the design basis of a plant.

[redacted]

Event Title	Rev.	RCA No.
Heavy Water Leak	0	NRU - 09 - 04289
s.18(b) **s.18(d)**		Impact No. NRU-09-04289

[redacted]

8.6 Inspections of J-Rod Annulus

Since approximately 1975, shortly after Vessel #2 was put into service, [redacted]

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Heavy Water Leak	0	NRU - 09 - 04289
s.18(b) **s.18(d)**		Impact No. NRU-09-04289

[redacted]